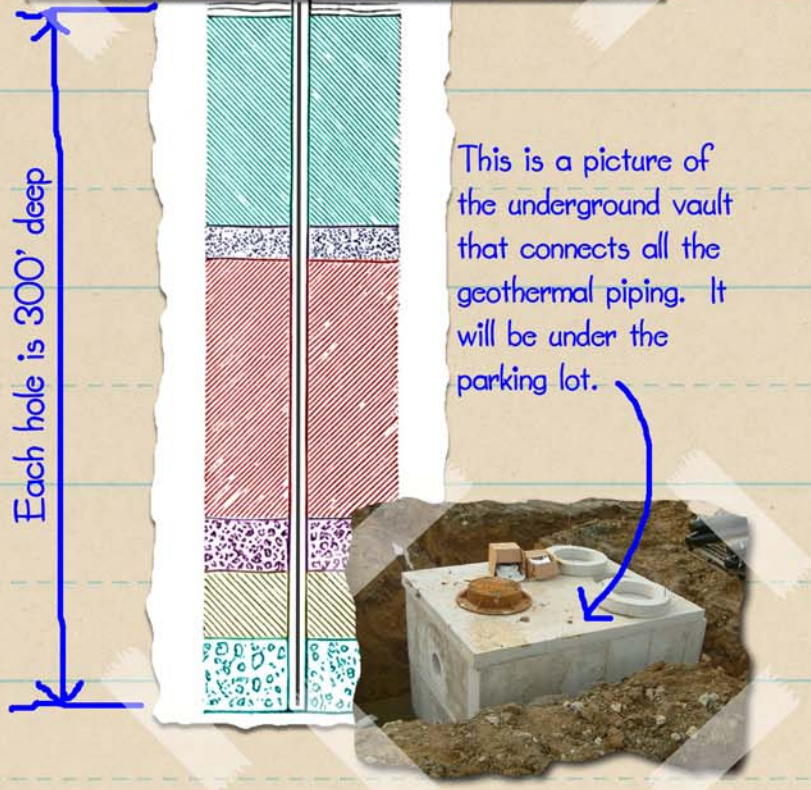
Picture #1

Picture #2

Science

My new school will be heated and cooled by a Geothermal Heating and Cooling System. 144 holes were drilled into the ground. They are about 300 feet deep. The holes have piping in them and they are all connected together and filled with antifreeze. In the winter the antifreeze is circulated through the piping in the earth and absorbs the stored heat from the ground and carries it indoors. Mechanical units in the building will compress the heat to a higher temperature and distribute it throughout the building. In the summer, the system reverses. Heat is pulled from the building, carried back into the cooler earth and deposited..

The system was designed by CMTA Engineering Consultants. They said it was three to four times more efficient than most other systems. The neat thing is that geothermal systems work with nature, not against it. The system does not burn any fossil fuel to generate heat. It simply transfers heat from the earth into the building. If a leak should ever happen in the underground piping, the antifreeze will not harm the environment.



I called CMTA Engineering Consultants to talk to them about the heating and cooling system for my new school. Mark Seibert told me the heating and air conditioning systems installed at my new school will be very energy efficient and will allow the teachers to have total control of room temperatures. My school will be heated and cooled utilizing a geothermal heat pump system. He told me geothermal heat pump systems are one of the most efficient types of heating and cooling systems to operate. He also said geothermal systems utilize the earth's underground temperatures to heat and cool the school. Additionally, with this system, any classroom can have heating or cooling at any time of the year.

To provide a quiet, noise free learning space, the heat pumps are located in various mechanical rooms. Placing these units in the mechanical rooms will eliminate the noise from the heat pump to the classroom, making it easier for my classmates and me to hear the teacher.

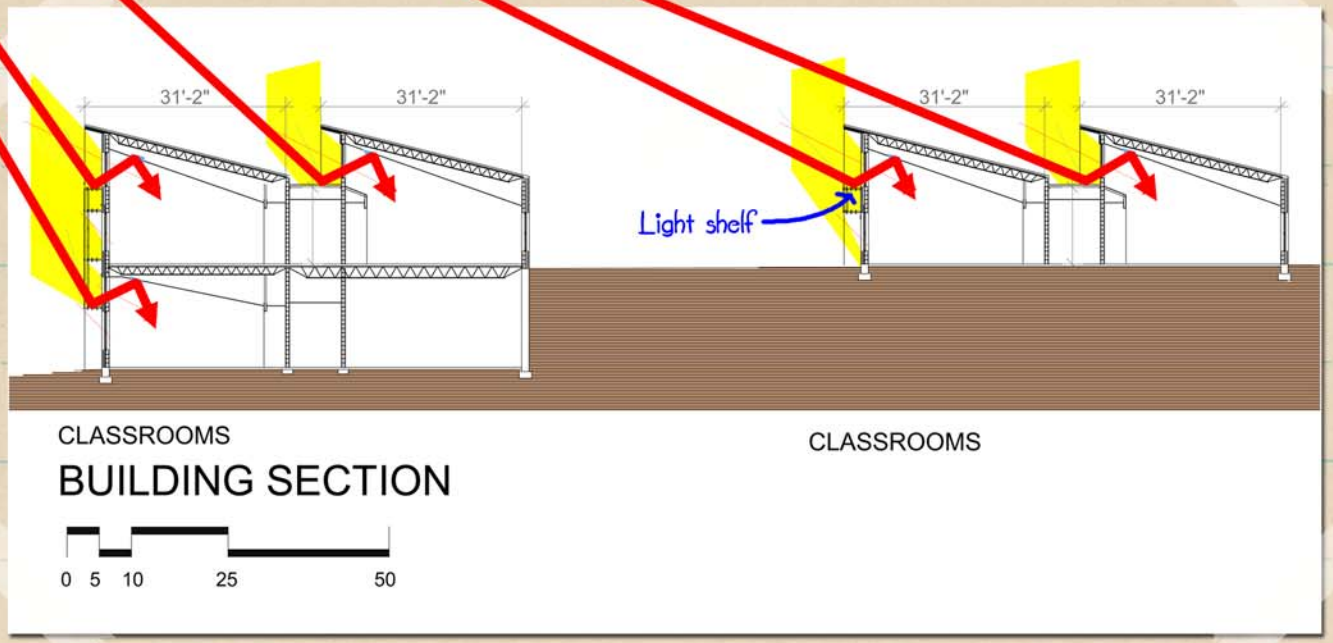
All of the building's heat pumps are controlled by computers through the Internet. The facilities staff, who will have a password and a computer connected to the Internet, can remotely change the temperature of any room. This type of system allows for continuous observations of the heat pumps. For example, if classroom temperatures are higher than expected, the computer controlling the heat pumps can call the school's maintenance person and tell him there is a problem.

In winter, fluid passing through this vertical, closed loop system is warmed by the heat of the earth; this heat is then transferred to the building (select image to enlarge).

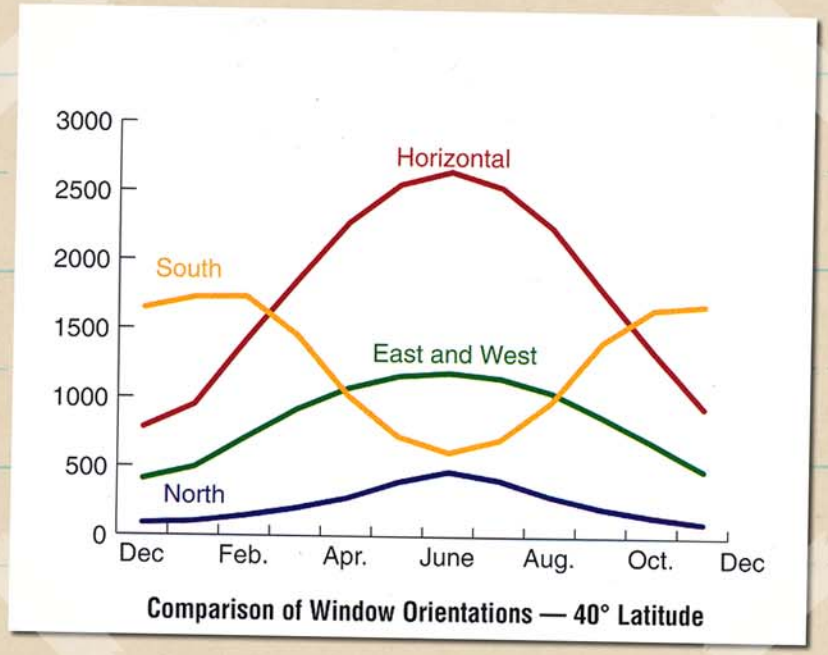
In summer, the fluid removes heat from the building and transfers it to the relatively cooler ground in order to cool the building (select image to enlarge).

I found this example of how a geothermal heat pump works at the U.S. Department of Energy - Energy Efficiency and Renewable Energy website. The web site address is "www.eere.energy.gov/consumerinfo/heatcool/hc_space_geothermal_types.html"

The architect gave me this drawing that shows how the light shelf restricts the amount of sun light entering the lower windows of my classroom. The light shelf also bounces sun light up to the ceiling and back down to my desk. It's better for my eyes that way. I can't wait to see my new classroom.

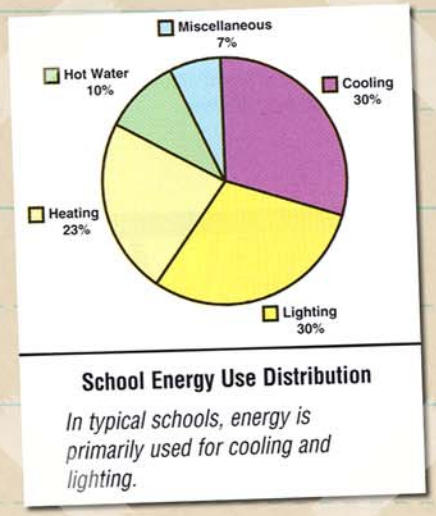


The architect also told me the amount of solar radiation (heat gain) striking windows varies depending on the time of year and the direction the windows face. Windows facing east, west, and north let in more solar radiation in the summer than they do any other time of year. So do skylights. Windows facing south let in less solar radiation in the summer than they do any other time of year because the sun is so high in the sky. Windows facing south let in the highest amount of solar radiation in the winter because the sun is so low in the sky. My school has most of its windows facing south and fewer windows facing east, west and north. By controlling solar radiation on the south elevation, my school will take advantage of the sun's light energy year around. When natural light is properly shaded, it doesn't lead to excessive heat gain. The windows at my new school will have three panes of special glass and built-in louvers to help minimize heat gain and glare in warmer months, and heat loss in colder months.



Comparison of Window Orientations — 40° Latitude

I found both of these charts in a book called "Energy Desgin Guidelines for High Performance Schools." It was written by the U.S. Department of Energy.



School Energy Use Distribution

In typical schools, energy is primarily used for cooling and lighting.

I hear my dad talk about the gas and electric bill. Gas and electricity costs a lot every month and it keeps going up. I looked on the Internet and read that the costs of energy over the life of a school building will far exceed the initial cost of the building.

I also learned that electric lights produce more waste heat energy than daylighting. Unwanted heat must be removed in the winter as well as the summer by ventilation and air conditioning.

Math

A+

Very Good! Next time remember to show all of your calculations

PROBLEM NO. 1

If the first floor of the new school is 47,984 square feet and the lower level is 30,865 square feet, what is the total square footage of the building?

$$\begin{array}{r} 47{,}984 \\ +30{,}865 \\ \hline 78{,}849 \end{array}$$

78,849 sf

PROBLEM NO. 2

If the Caywood School site has 291,488 square feet and if there are 43,560 square feet to an Acre, how many Acres are there on the Caywood site?

$$43{,}560 \overline{)\,291{,}488} \quad 6.69$$

6.69 acres

PROBLEM NO. 3

If the site work cost $1,409,363, and the geothermal loop field cost $430,400 and the building cost $10,634,000 what is the total construction cost of the new school?

$$\begin{array}{r} 1{,}409{,}363 \\ 430{,}400 \\ +10{,}634{,}000 \\ \hline 12{,}473{,}763 \end{array}$$

$12,473,763

PROBLEM NO. 4

After you have calculated the total construction cost for the building in Problem No. 3, what is the cost per square foot of the new building? (HINT: You will need to use your answer from Problem No. 1 to determine this answer)

$$78{,}849 \overline{)\,12{,}473{,}763} \quad 158.19$$

$158.19/sf